Characterizing Weed Community Seedling Emergence for a Semiarid Site in Colorado[1]

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Abstract. This study characterized the emergence pattern of a weed community of 16 species between April 1 and August 31 over a 7-yr period. Weed seedlings were counted weekly in quadrats established in winter wheat stubble within no-till and conventional-till production systems. Weed emergence showed two peaks, the first between April 25 and May 9, and the second between May 30 and June 13. Tillage did not affect the weed community emergence pattern. Knowledge of weed community emergence pattern in conjunction with crop simulation models could be used to suggest cultural practices such as optimal planting dates that favor a crop over weeds, and possibly reduce herbicide use for within-crop weed control. **Nomenclature:** Winter wheat, *Triticum aestivum* L.

Additional index words: Crop models, cultural practices, integrated weed management systems, low-herbicide-input production systems.

INTRODUCTION

Winter wheat-fallow is the most common rotation in the semiarid Central Great Plains, where precipitation stored in the soil during fallow stabilizes winter wheat production (11). However, improved fallow systems have increased precipitation storage (19, 25) to the extent that more intensive cropping is now feasible. For example, winter wheat-corn *(Zea mays* L.)-fallow produced > 70% more grain over a 6-yr period than winter wheat-fallow (21, 26). Increasing cropping intensity may also be more profitable for the producer (10, 22).

Several summer annual crops are adapted to this region when grown after winter wheat, such as proso millet *(Panicum miliaceum* L.) (3, 21), corn (2, 26), oat *(Avena sativa* L.) for forage (16), safflower *(Carthumus tinctorius* L.) (l), and sunflower *(Helianthus annuus* L.) (16).

One concern with some of these summer annual crops is lack of registered and effective herbicides for within-crop weed control. With limited hectarage of these crops, it is not conducive for the pesticide industry to invest resources in developing and registering herbicides. Secondly, public environmental concerns may limit future herbicide options (17).

Because of these potential limitations, non-chemical weed control methods need to be explored (32), including management practices that favor the crop over weeds (4). Historically, cultural practices have been a major component of weed management systems (24, 29). For example, producers in the semiarid Great Plains minimized the impact of downy brome *(Bromus tectorum* L.) and jointed goatgrass *(Aegilops cylindrical* Host.) in winter wheat by delaying winter wheat planting, which allowed these weeds to emerge before planting so that they could be controlled with tillage or herbicides (30).

Knowledge about the weed community emergence pattern could suggest planting dates for summer annual crops with limited herbicide options that may minimize weed interference. In the Corn Belt, knowledge of weed seed bank population and its subsequent emergence guides planting time of soybean *[Glycine max* (L.) Merr.] to minimize weed interference for low-pesticide-input production systems (6, 9). Because several summer annual crops are available for the Central Great Plains (2, 16, 21), a wide window of planting times exists, enabling the producer to alter time of planting through crop choice.

Knowledge of the weed community emergence pattern may also benefit growth simulation models that have been developed for crops grown in this region (13, 18, 31). The erosion productivity impact calculator (EPIC)[3] model simulates development of sunflower based on weather variables (13). Using the location's heat units and radiation intensity, EPIC can predict periods of peak crop growth based on leaf area index and plant height. These crop growth models could integrate information on weed community emergence patterns to select crops or the optimal

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[3]Abbreviations: EPIC, erosion productivity impact calculator.

planting date for a selected crop that results in peak crop growth before a major flush of weeds occurs. Therefore, the crop would gain a competitive advantage over weeds (4).

Emergence patterns have been described for specific weeds (20, 28), but not for a weed community in a field. Biological characterization of weed communities has been limited to species composition (5, 12). Therefore, this study characterizes the seedling emergence pattern over a 7-yr period for a field's weed community during the period between April 1 and August 31.

MATERIALS AND METHODS

Site description. The study was conducted 7 km east of Akron, CO, on a Weld silt loam (fine, montmorillonitic, mesic Aridic Paleustoll) with 1.2% organic matter and a pH of 6.9 (O to 15 cm depth). The average weekly precipitation and air temperatures at this site over 87 yr for the period between April 1 to August 31 are shown in Figure 1. Weekly precipitation ranges from 7 to 23 mm, with the weeks ending on May 30 and June 6 receiving the highest precipitation. The average precipitation for the measurement period is 293 mm. Average daily air temperatures increase from 5 C in early April to 23 C in late July, at a rate of approximately 1 C per week, then decrease to 21 C by late August.

Study procedures. From 1987 to 1990, 12 l-m^2 quadrats were established in winter wheat stubble within a no-till and conventional-till production system. The cropping history of this site was winter wheat-corn-fallow. The no-till system relied on foliar-applied herbicides for fall weed control, whereas the conventional-till system (prevalent practice used by producers in this region) controlled weeds with two sweep plow[4] operations in the fall after winter wheat harvest. Corn was planted around the study site, but not in the quadrats. From 1991 to 1993, four 1-m^2 sites were established in a different portion of the same field, where the cropping history was winter wheat-fallow. For all 7 yr, study sites were established in a different location in the same field, within a radius of 1 km.

Seedling emergence by the weed community was recorded weekly, starting on April 1 and continuing through August 31. After counting, seedlings were pulled and removed from each quadrat. Total seedlings per year ranged from 130 to 1250/m^2, averaging approximately 325 seedlings per m^2 per year. The source of weed seed was the indigenous weed seed bank. After initiation of counting, weeds were not controlled in the quadrats for the duration of the data collection period.

Species observed in the study are listed in Table 1. Kochia, Russian thistle, green foxtail, wild-proso millet, redroot pigweed, smooth pigweed, and volunteer wheat were present at all sites and comprised over 80% of the total seedlings observed. Species occurrence by individual year is shown in Table 2.

[4]The sweep plow consists of V-shaped blades that sever weed roots with mini mum soil disturbance. leaving crop residue on the soil surface.

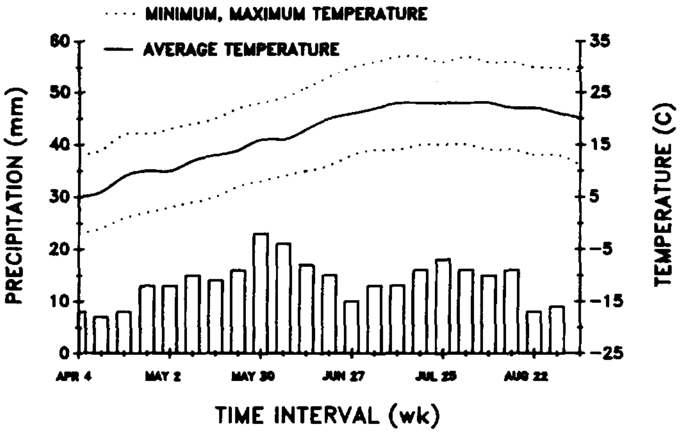

Figure 1. Long-term precipitation (bars) and daily air temperatures (lines) at Akron, CO, averaged by weekly intervals. Period used to determine average was 1907 to 1993.

Table 1. Weed species observed over the 7-yr period at Akron, CO.

Common name	Scientific name
Monocots	
Downy brome	*Bromus tectorum* (L.) #[a] BROTE
Green foxtail	*Setaria viridis* (L.) Beauv. # SETVI
Longspine sandbur	*Cenchrus longispinus* (Hack.) Fern. # CCHPA
Stinkgrass	*Eragrostis cilianensis* (All.) E. Mosher # ERACN
Volunteer wheat	*Triticum aestivum* L. # TRIAE
Wild-proso millet	*Panicum miliaceum* L. # PANMI
Dicots	
Common purslane	*Portulaca oleracea* L. # POROL
Common sunflower	*Helianthus annuus* L. # HELAN
Horseweed	*Conyza canadensis* (L.) Cronq. # ERICA
Kochia	*Kochia scoparia* (L.) Schrad. # KCHSC
Prostrate pigweed	*Amaranthus blitoides* S. Wats. # AMABL
Puncturevine	*Tribulus terrestris* L. # TRBTE
Redroot pigweed	*Amaranthus retroflexus* L. # AMARE
Russian thistle	*Salsola iberica* Sennen & Pau # SASKR
Smooth pigweed	*Amaranthus hybridus* L. # AMACH
Wild buckwheat	*Polygonum convolvulus* L. # POLCO

[a]Letters following this symbol are a WSSA-approved computer code from Composite List of Weeds, Revised 1989. Available from WSSA, 1508 West University Ave., Champaign, IL 61821-3133.

Table 2. Occurrence of weed species by individual year over the duration of the study[a].

Common name	Site						
	1987	1988	1989	1990	1991	1992	1993
Downy brome	x	x	x	x	—	x	—
Green foxtail	x	x	x	x	x	x	x
Longspine sandbur	x	—	x	x	x	—	—
Stinkgrass	x	x	—	—	x	—	x
Volunteer wheat	x	x	x	x	x	x	x
W!ld-proso millet	x	x	x	x	x	x	x
Common purslane	—	x	x	—	—	x	x
Common sunflower	x	x	—	x	x	—	—
Horseweed	—	—	—.	x	—	x	x
Kochia	x	x	x	x	x	x	x
Prostrate pigweed	—	x	x	x	—	x	x
Puncturevine	x	x	x	—	x	—	x
Redroot pigweed	x	x	x	x	x	x	x
Russian thistle	x	x	x	x	x	x	x
Smooth pigweed	x	x	x	x	x	x	x
Wild buckwheat	—	—	x	—	—	—	x

ax signifies that the weed species was present in that year

Emergence pattern for each year was developed by converting seedling emergence per week into a percentage of total emergence between April 1 and August 31 for all replications. Data over the 7 yr were then averaged by weekly intervals, with one standard deviation derived from yearly averages for each week.

RESULTS AND DISCUSSION

Weed community emergence pattern. Weed emergence showed two major peaks, one peak between April 25 and May 9, and a second peak between May 30 and June 13 (Figure 2). Kochia and Russian thistle were the main species emerging during the first peak, whereas green foxtail, wild-proso millet, and pigweed species predominated in the second peak. A prominent gap in emergence occurred between May 9 and May 23, with weekly emergence averaging only 4% of total emergence. After the second peak in late May-early June, weekly emergence dropped to ≤ 3%. The two peaks represent 67% of the total weed seedling emergence.

Tilling the soil increased the number of seedlings emerging within the weed community, but did not affect the community emergence pattern (data not presented). This community emergence response to tillage is similar to that of individual species, where tillage increased the magnitude of emergence but did not alter the emergence pattern (8, 20, 23). Therefore, data were averaged over tillage systems to develop the emergence pattern. Also, crop rotation (winter wheat-corn-fallow vs winter wheat-fallow) did not affect community emergence pattern among years.

Precipitation during the 7 yr was erratic, as shown by the standard deviation being greater than the mean in several weeks (Figure 3). Although variability in precipitation is common for this region, weekly means during the 7-yr period were similar to the 87-yr long-term means (Figures 1 and 3).

Variability in precipitation contributed to variability in seedling emergence (Figure 2); however, precipitation anomalies did not correspond to the low seedling emergence in mid-May and late June. Seedlings typically

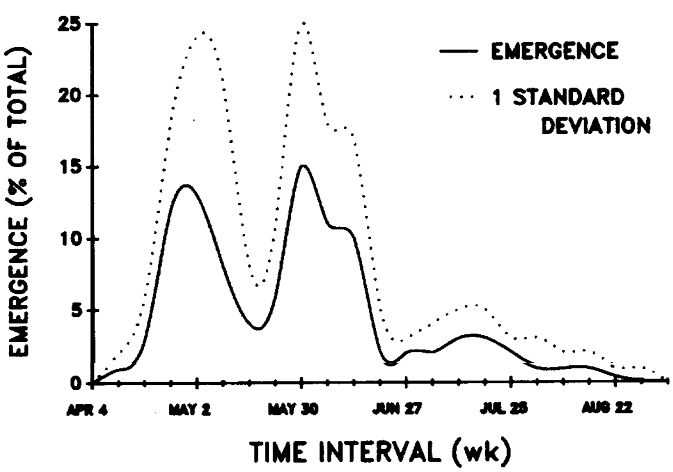

Figure 2. Weed community emergence pattern (solid line) averaged over 7 yr, 1987–1993. Dotted line represents 1 standard deviation.

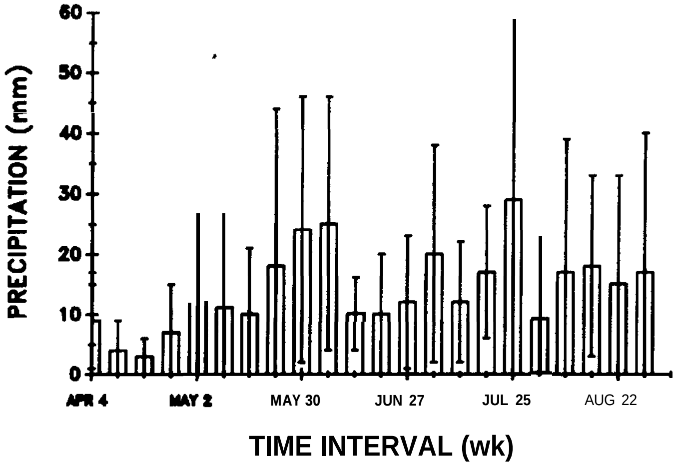

Figure 3. Average weekly precipitation over the duration of the study, 1987 to 1993. Vertical lines represent 1 standard deviation of precipitation averages for each week.

emerged 7 to 14 d after precipitation. Precipitation from April 25 to May 9, which would stimulate seedlings to emerge between May 9 and May 16 (when emergence was 4%), was approximately 85% of normal, whereas precipitation 2 wk before June 20 (when emergence was 1 %) was 92% of normal. Therefore, the emergence pattern reflects the weed community biological characteristics rather than unusual precipitation.

Management implications. Crop models have potential to help guide producer decisions in crop selection to minimize wind and water erosion (15, 27), and to maximize crop production in saline soils within regional climatic variables (14). Weed community emergence patterns also could be integrated into crop models to aid producers in selecting the appropriate crop and cultural practices to increase crop competitiveness with weeds.

For example, oil seed crops such as safflower and sunflower are grown in this region. Time of planting varies between these crops, with safflower being planted in early April and sunflower in early June. Potential number of weeds emerging during the growth period of these crops contrasts drastically, based on the emergence pattern (Figure 2). With safflower, over 70% of total weed seedlings would emerge within 10 wk of planting. However, if sunflower was planted after June 13, over 80% of the weed seedlings would have emerged before planting, and thus they could be easily controlled with either tillage or herbicides. Producers could minimize within-crop weed pressure significantly by planting sunflower rather than safflower.

Weed community emergence data also could suggest optimum planting dates to maximize crop competitiveness with weeds. For example, oat is, planted from late March to late April in the Central Great Plains. Stem elongation of oat, a period of rapid growth with increasing plant height, occurs in May. Because crop models such as EPIC can predict when oat stem elongation will occur, a crop growth simulation based on long-term weather variables for this site could suggest planting dates where stem elongation occurs before the second emergence peak in late May. This would favor oat over the later emerging weeds.

Coupling planting date knowledge gained from the weed community emergence pattern with other cultural practices may further reduce the need for herbicide input to control weeds within a crop. With sunflower, when row spacing was reduced from 76 to 25 cm, acceptable in-crop weed control was achieved with only 25% of the normal rate of trifluralin [2,6-dinitro-N, N-dipropyl-4-(trifluoromethyl)benzenamine] (7). Integrating delayed planting of sunflower with reduced row spacing may reduce the rate of herbicide needed for sunflower production in the Central Great Plains. Sunflower yield response to planting date has been developed[5] therefore, producers could determine a cost-benefit ratio for delayed planting with narrow rows and reduced trifluralin rate in comparison to planting sunflower earlier with greater herbicide inputs.

[5]High Plains Sunflower Production and IPM. Colorado State Univ. Coop. Ext. Bull. 556A, Ft. Collins, CO 80523.

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